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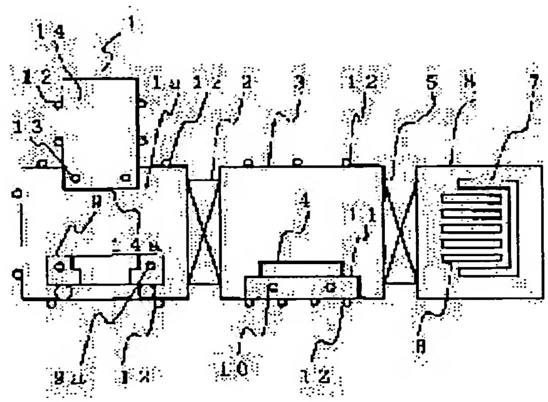
(54) SYSTEM AND METHOD FOR CHARGED PARTICLE BEAM

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a system having improved throughput by reducing the time for waiting the stabilization of a sample size caused by cooling of atmosphere gas, due to adiabatic expansion in a load lock chamber.

SOLUTION: The temperature of a treatment chamber is set lower than the ambient temperature of charged particle beams, corresponding to the sample temperature to be carried. As a result, treatment can be started, immediately after carrying the sample into the treatment chamber, and thereby throughput is improved.



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CLAIMS

[Claim(s)]
[Claim 1] Charged-particle line equipment characterized by setting it as temperature lower than the temperature of said perimeter of charged-particle line equipment according to the temperature of the sample conveyed in the temperature of said processing room at said processing room in the charged-particle line equipment which possesses a load lock chamber and the processing room which maintains a vacua, and performs predetermined processing to a sample in said processing interior of a room.
[Claim 2] Charged-particle line equipment according to claim 1 characterized by a low temperature setup of said processing room estimating the temperature fall by the adiabatic expansion of a load lock chamber.

[Claim 3] Charged-particle equipment according to claim 1 or 2 characterized by for said sample being a sample for semi-conductor manufacture, for said charged-particle line being an electron ray, and said predetermined processing being exposure.
[Claim 4] Charged-particle line equipment given in claims 1-3 characterized by the temperature of said perimeter of charged-particle line equipment being the temperature which flows the inside of the temperature control pipe of a load-lock-chamber outside.
[Claim 5] The semi-conductor exposure approach characterized by carrying out a temperature setup lower than the temperature of the perimeter of a load lock chamber according to the sample temperature which has the temperature of said processing room conveyed by the semi-conductor exposure approach using a load lock chamber and the processing room which maintains a vacua.
[Claim 6] The inspection approach characterized by carrying out a temperature setup lower than the temperature of the perimeter of a load lock chamber according to the sample temperature which has the temperature of said processing room conveyed by the inspection approach using a load lock chamber and the processing room which maintains a vacua.
[Claim 7] The measuring method characterized by carrying out a temperature setup lower than the temperature of the perimeter of a load lock chamber according to the sample temperature which has the temperature of said processing room conveyed by the measuring method using a load lock chamber and the processing room which maintains a vacua.
[Claim 8] The semi-conductor exposure approach according to claim 5 characterized by a low temperature setup of said processing room estimating the temperature fall by the adiabatic expansion of said load lock chamber.
[Claim 9] The inspection approach according to claim 6 characterized by a low temperature setup of said processing room estimating the temperature fall by the adiabatic expansion of said load lock chamber.
[Claim 10] The measuring method according to claim 7 characterized by a low temperature setup of said processing room estimating the temperature fall by the adiabatic expansion of said load lock chamber.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is further concerned with the manufacture approach using those equipments and a device, the inspection approach, and a measuring method about the aligner using charged-particle lines used for the lithography of a semiconductor integrated circuit etc., such as an electron ray aligner and an ion beam aligner, test equipment, and measuring equipment. It is the aligner especially exposed under a vacuum, and is related with a high throughput, highly precise and suitable equipment to perform lithography, and the manufacture approach.
[0002]
[Description of the Prior Art] In a vacuum, about a semi-conductor etc., in order to carry out manufacture, inspection, and measurement, there is a method called a batch type from the former. By this method, a sample is directly carried in to a processing room out of atmospheric air, the air of a processing room is exhausted after carrying in, and predetermined processing is performed, after heating a sample, in order to compensate the temperature fall by the adiabatic expansion produced in that case. However, by this method, whenever it exchanged samples, the processing room needed to be made into the vacua from the condition of atmospheric pressure, and exhausting had taken long time amount. Furthermore, in order to control the temperature conditions of the processing interior of a room to a precision, over long time amount, temperature control needed to be carried out and temperature of a sample needed to be made into predetermined temperature. Consequently, there was a fault that the effectiveness of processing was very low.
[0003] Therefore, in recent years, a sample is not carried in to a direct-processing room, but it carries in to the load lock chamber maintained at atmospheric pressure first, and the air of this load lock chamber is exhausted, it is made a vacua, and, generally the method of carrying in a sample to the sample room of a vacua in that condition is taken increasingly widely.
[0004]
[Problem(s) to be Solved by the Invention] With the conventional equipment which prepared the load lock chamber, where a sample is carried in to a load lock chamber, in case evacuation of a load lock chamber is carried out, the controlled atmosphere of a load lock chamber is cooled for the adiabatic expansion produced when decompressing a pressure, this cooled gas cools a sample, and the temperature of a sample is reduced. Although the fall of this temperature is based also on conditions, such as volume of a load lock chamber, heat capacity, and heat capacity of a sample, in the case of 10l. of volume numbers of load locks chamber usually used, it falls by 2-3 degrees C, for example. The dimension of a sample is contracted by this temperature fall.
[0005] Since a 1-degree C temperature change causes a 0.5-micrometer dimensional change when 8 inches Si wafer is used, a 2-3-degree C temperature fall causes contraction of a sample dimension of 1 micrometers or more. This is a dimensional change which poses a problem to the aligner, the test equipment, or the measuring device for a large-scale integrated circuit, and cannot fulfill the precision prescribe needed for manufacture.
[0006] If this sample that the dimension contracted by temperature fall is carried in to a processing room, it will be placed into the ambient atmosphere of processing temperature, and will be warmed shortly, and a sample will begin thermal expansion. The thermal expansion of a sample stops, and exposure at a

processing room is performed after waiting for sample temperature and a sample dimension to continue all over a sample, and to stabilize them. This latency time becomes long especially, when performing highly precise exposure. For example, to use 8 inches Si wafer with a charged-particle aligner, it is required to suppress a dimensional change to 10nm or less, and it is necessary to keep a temperature gradient at 0.02 degrees C or less for that purpose. In order to fulfill a temperature gradient 0.02 degrees C or less, with conventional equipment, there was a problem that the latency time also for dozens of minutes was required, and this latency time caused the fall of a throughput.

[0007] This invention was made that a problem peculiar to the equipment which used the above-mentioned load lock chamber should be solved, decreases the time amount which waits for the stability of the sample dimension resulting from cooling of the controlled atmosphere by the adiabatic expansion in a load lock chamber, and aims at offer of the equipment which raises a throughput. Furthermore, it aims at offering the outstanding manufacture approach and the outstanding inspection approach using this equipment, and a measuring method.

[0008]

[Means for Solving the Problem] The charged-particle line equipment characterized by to set [in the charged-particle line equipment which possesses ″load lock chamber and the processing room which maintains a vacua in the first place, and performs predetermined processing in the first place to a sample in this invention in said processing interior of a room] it as temperature low than the temperature of said perimeter of charged-particle line equipment according to the temperature of the sample conveyed in the temperature of said processing room at said processing room in order to raise the throughput of a load lock type vacuum processor. (Claim 1) ″ — it provides.

[0009] Thereby, the latency time in a processing room decreases and a throughput improves. moreover — this invention — the second — ″— the charged-particle line equipment according to claim 1 characterized by a low temperature setup of said processing room estimating the temperature fall by the adiabatic expansion of a load lock chamber. (Claim 2) ″ — it provides.

[0010] moreover — this invention — the third — ″— the charged-particle aligner according to claim 1 or 2 characterized by for said sample being a sample for semi-conductor manufacture, and said charged-particle line being an electron ray. (Claim 3) ″ — it provides. Thereby, manufacture of the semi-conductor in a high throughput is attained.

[0011] moreover — this invention — the fourth — ″— charged-particle line equipment given in claims 1-3 characterized by the temperature of said perimeter of charged-particle line equipment being the temperature which flows the inside of the temperature control pipe of a load-lock-chamber outside. (Claim 4) ″ — it provides. Moreover, the semi-conductor exposure approach characterized by carrying out a temperature setup lower than the temperature of the perimeter of a load lock chamber to the fifth according to the sample temperature which has the temperature of said processing room conveyed by the semi-conductor exposure approach using ″load lock chamber and the processing room which maintains a vacua in this invention. (Claim 5) ″ — it provides. Thereby, the latency time in a processing room decreases and a throughput improves.

[0012] Moreover, the inspection approach characterized by carrying out a temperature setup lower than the temperature of the perimeter of a load lock chamber to the sixth according to the sample temperature which has the temperature of said processing room conveyed by the inspection light approach using ″load lock chamber and the processing room which maintains a vacua in this invention. (Claim 6) ″ — it provides. Thereby, the latency time in a processing room decreases and a patient throughput improves.

[0013] Moreover, the measuring method characterized by carrying out a temperature setup lower than the temperature of the perimeter of a load lock chamber to the seventh according to the sample temperature which has the temperature of said processing room conveyed by the measuring method using ″load lock chamber and the processing room which maintains a vacua in this invention. (Claim 7) ″ — it provides. Thereby, the latency time in a processing room decreases and measurement effectiveness improves.

[0014] moreover — this invention — the eighth — ″— the semi-conductor exposure approach according to claim 5 characterized by a low temperature setup of said processing room estimating the temperature fall by the adiabatic expansion of said load lock chamber. (Claim 8) ″ — it provides. moreover — this invention — the ninth — ″— the inspection approach according to claim 6 characterized by a low temperature setup of said processing room estimating the temperature fall by the adiabatic expansion of

said load lock chamber. (Claim 9) ″ — it provides.
[0015] moreover — this invention — the tenth — ″— the measuring method according to claim 7 characterized by a low temperature setup of said processing room estimating the temperature fall by the adiabatic expansion of said load lock chamber. (Claim 10) ″ — it provides.
[0016]
[Example] The example of the load lock type vacuum processor applied to this invention taking the case of an electron ray aligner and an approach is explained. Drawing 1 shows the structure of the electron ray aligner of this invention. This electron ray aligner consists of an exposure section body 1, a load lock chamber 3, and an atmospheric-air room 8.
[0017] The pressure inside the atmospheric-air room 8 is always maintained at atmospheric pressure, and two or more samples 6 are settled in the sample carrier 7, and are kept. Temperature is placed in the environment always kept constant. The metal electrode holder 11 is arranged inside the load lock chamber 3. The temperature control pipe 10 for electrode holders is built into the interior of an electrode holder 11, and the temperature of an electrode holder 11 is controlled by the fluid by which the temperature which flows the inside of the temperature control pipe 10 for electrode holders was controlled. In the electrode holder 11 and the field, electrode-holder table A4 touches and is arranged on the top face of an electrode holder 11. For this reason, it is controlled so that electrode-holder table A4 also becomes a value predetermined in temperature by heat conduction from an electrode holder 11.
[0018] Around the load lock chamber 3, the temperature control pipe 12 is arranged in contact with the outer wall, and the temperature of a load lock chamber 3 can be controlled now by pouring the fluid by which temperature control was carried out. Furthermore, a robot arm (not shown) is arranged in a load lock chamber 3, and a sample 6 can be conveyed now between a load lock chamber 3 and processing room 1a. This robot arm (not shown) can convey a sample 6 now between the atmospheric-air room 8 and a load lock chamber 3.
[0019] The bulb 5 has clung, a septum with the atmospheric-air room 8 can move, and the end of a load lock chamber 3 can unify a building envelope, if a bulb 5 is opened. Moreover, if a bulb 5 is shut, it can be isolated with the atmospheric-air room 8, and can also become separate space.
[0020] The electron ray lens section 14 is installed in the upper part of the exposure section body 1, and processing room 1a always maintained at the vacuum is arranged at the lower part. In processing room 1a, the electrode-holder table B9 holding a sample 6 is placed. Temperature control pipe 9a for electrode-holder tables is laid under the interior of the electrode-holder table B9, and the temperature of electrode-holder table 9a can be controlled now by pouring the fluid by which temperature control was carried out.
[0021] The temperature control pipe 13 for electron lens section inferior surfaces of tongue is incorporated, and electron ray lens section inferior-surface-of-tongue 14a can control now the temperature of electron ray lens section inferior-surface-of-tongue 14a by pouring the fluid by which temperature control was carried out. Around the exposure section body 1, the temperature control pipe 12 is arranged in contact with the outer wall, and the temperature of the exposure section body 1 can be controlled now by pouring the fluid by which temperature control was carried out. A bulb 2 is arranged and load-lock-chamber 3 building envelope can consider as one by opening a bulb 2 at the end of the exposure section body 1. Moreover, if a bulb 2 is shut, it can also become space separate from a load lock chamber 3.
[0022] Next, the temperature of each part is described. it is arranged on the outside of a load lock chamber 3 so that the temperature control pipe 12 may touch a load lock chamber 3, and since the fluid which is the ambient temperature, i.e., installation environmental temperature, on which the electron ray aligner is put in the inside of it and which was usually kept at 23 degrees C flows, it is maintained at the temperature of about 1 law. Furthermore, the temperature control pipe for electrode holders laid under the electrode-holder 11 interior is also kept the same to installation environmental temperature. The temperature control pipe 12 is installed in the external surface of the exposure section body 1, and in order that the fluid which is installation environmental temperature and which was usually kept at 23 degrees C may flow the inside of it, it is kept the same to almost fixed temperature.
[0023] On the other hand, to temperature control pipe 9for electrode-holder tables a, and the temperature control pipe 13 for electron ray lens section inferior surfaces of tongue, the fluid of temperature [a little] lower than installation environmental temperature is poured. This temperature gradient looks at the part of the temperature fall produced by decompressing a load lock chamber 3, and

is crowded.
[0024] Next, conveyance of a sample is explained using Fig. 2. In the first condition, two or more samples 6 are stored in the atmospheric-air room 8 in the condition of having been stored in the sample carrier 7. Two or more samples 6 are maintained at environmental laying temperature in this condition. The bulb 2 is shut and the exposure section body 1 is maintained at the vacua. On the other hand, the bulb 5 is opened and the load lock chamber 3 is in the condition that atmospheric pressure is added.
[0025] In order to convey the sample 6 placed into the atmospheric-air room 8 to processing room 1a, one sheet of the sample 6 first stored in the carrier 7 by the robot arm (not shown) installed in the load lock chamber 3 is conveyed in B location via C location. Next, a bulb 5 is closed, and the air of the load-lock-chamber 3 interior will be exhausted by the vacuum pump (not shown), and will be in a vacua. At this time, the temperature in a load lock chamber 3 falls by adiabatic expansion. Although the temperature of the sample 6 placed into the load lock chamber 3 is the temperature when being left in the atmospheric-air room 8 at first, it is cooled little by little by adiabatic expansion.
[0026] If a load lock chamber 8 reaches a vacuum, a bulb 2 will open and it will be carried to A location from B location by the robot arm (not shown) prepared in the load lock chamber 3. A location is a position on the electrode-holder table B9, and a sample 6 is fixed to this location.
[0027] The temperature of the carried sample 6 has fallen a little rather than the installation environmental temperature of about 23 degrees C for the adiabatic expansion in a load lock chamber 3. On the other hand, temperature control pipe 9for electrode-holder tables a and the temperature control pipe 13 for the electron ray lens sections expect a part for the temperature fall by adiabatic expansion, and have set it up lowness. Therefore, since a temperature gradient with a sample 6 is not produced, there is little latency time for canceling a temperature gradient, and it is immediately exposed after carrying in.
[0028] While the sample 6 is exposed, the following sample 6 is carried to B location in the same procedure. If exposure within vacuum chamber 1a is completed, a bulb 2 will be opened and a sample 6 will be carried to E location from A location by the robot arm (not shown) prepared in the load lock chamber 3. At this time, the bulb 5 is closed and the load lock chamber 3 has become a vacua. The following sample 6 which was standing by to this and coincidence in B location is conveyed immediately similarly in A location, and a bulb 2 is closed and is exposed after that. While being exposed, the sample 6 which a bulb 5 opens and is in E location returns from E location to D location via F location by the robot arm (not shown) prepared in the load lock chamber 3. Then, the following sample 6 is similarly carried to B location via C location from D location. Thus, carrying in and taking out of a sample 6 are performed repeatedly.
[0029] Although the above-mentioned example explained the case where this invention was applied to an electron ray aligner, fundamentally, this invention is available with all the equipments using a load lock chamber. Therefore, it cannot be overemphasized that it is applicable to measuring devices, such as an another side-type aligner, such as an ion beam aligner, test equipment using an electron ray, and an electron microscope, etc.
[0030]
[Effect of the Invention] Since time amount until sample temperature is stabilized and it becomes uniform temperature distribution can be sharply shortened after a sample is conveyed and being carried in the sample stage of a processing room in a load lock type vacuum processor if this invention is followed as above, the throughput of a load lock type vacuum processor is raised sharply, and it becomes possible to perform the process of a semi-conductor, exposure, inspection measurement, etc. with high precision moreover.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the structure of the load-lock-chamber vacuum processor by this invention.
[Drawing 2] In a load-lock-chamber vacuum processor, it is drawing showing the example of the conveyance sequence of a sample.
[Description of Notations]
1 Exposure Section Body
1a Processing room
2 Bulb
3 Load Lock Chamber
4 Electrode-Holder Table A
5 Bulb
6 Sample
7 Sample Carrier
8 Atmospheric-Air Room
9 Electrode-Holder Table B
9a The temperature control pipe for electrode-holder tables
10 Temperature Control Pipe for Electrode Holders
11 Electrode Holder
12 Temperature Control Pipe
13 Temperature Control Pipe for Electron Lens Section Inferior Surfaces of Tongue
14 Electron Ray Lens Section
14a electron ray lens section inferior surface of tongue

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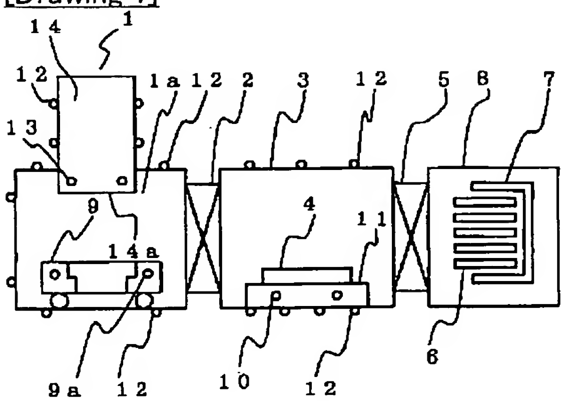
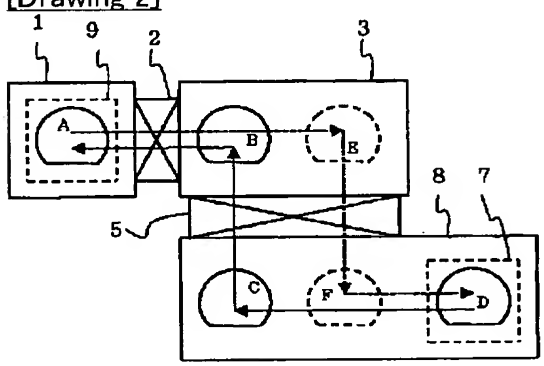
DRAWINGS

[Drawing 1]



[Drawing 2]



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